Later Jomon Subsistence in Northeastern Japan: New Evidence from Palaeoethnobotanical Studies

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THE TOHOKU REGION OF NORTHEASTERN JAPAN has the potential for providing several avenues of research into human palaeoeconomic issues and general processes of culture change (e.g., Akazawa 1986*a*; Crawford and Takamiya 1990; D'Andrea et al. 1995). Rice farming, for example, was introduced to Tohoku, making this area a natural laboratory in which to chart the dispersal of agriculture and the resulting cultural-ecological implications. This potential, for the most part, has been untapped. Although subsistence models have been proposed for Tohoku later Jomon cultures based on tool assemblages and faunal studies (e.g., Akazawa 1986*a*), little archaeobotanical research has been carried out in this region. In contrast, palaeoethnobotanical research is well established in nearby southwestern Hokkaido, and has been ongoing since the 1970s (e.g., Crawford 1983, 1992*b*; Crawford et al. 1976; Crawford and Takamiya 1990; Crawford and Yoshizaki 1987; Tsubakisaka 1988; Yamada 1986, 1987; Yamada and Tsubakisaka 1989). The present study is an outgrowth of the Hokkaido work, and it focuses on producing evidence in the form of archaeobotanical data that may further clarify the palaeoeconomy of later Jomon peoples of northeastern Tohoku.

The research described herein is part of a larger palaeoethnobotanical study undertaken in eastern Aomori and southwestern Hokkaido (D'Andrea 1992, 1995; D'Andrea et al. 1995). In particular, it focuses on work carried out in Aomori, the northernmost prefecture in the Tohoku region of northern Japan at the sites of Tominosawa and Kazahari. These two localities represent sedentary villages that range in age from the late Middle Jomon to the latest Final Jomon (Fig. 1). The work represents the first systematic palaeoethnobotanical study undertaken in the Aomori region, the primary objective being to examine aspects of later Jomon subsistence. A secondary goal was to elucidate processes of pithouse deposition using archaeobotanical remains. The results add to the general picture of human subsistence in the late Middle Jomon period and also provide insights into the dispersal of domesticated plants into the area.

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Asian Perspectives, Vol. 34, No. 2, © 1995 by University of Hawai'i Press.

	SW Japan	Aomori				SW Hokkaido
						Ainu
A.D. 1333	Kamakura					
A.D. 1185	Nara-Heian					Ezo
A.D. 710			Southern		Northern	
	Kofun					
A.D. 300						
	Late		Sakurai		Chokaiyama	
	Yayoi	Tohoku	Enda		Nenbutsuma	
A.D. 100		Yayoi				Zoku-Jomon
			Matsukata Gakoi		Inakadate	
	Middle				Utetsu II	
150 B.C.	Yayoi		Tanakura		Nimaibashi	
			Fukurashima		Sunazawa	
100 B.C.					?Fukurashima	Final Jomon
	Early			Obora A'		
300 B.C.	Yayoi	Final Jomon		Obora A		
				Obora C2		
	Final			Obora C1		
	Jomon			Obora BC		
				Obora B		
1000 B.C.				Tokoshinai V		
				Tokoshinai III/IV		
		Late Jomon		Tokoshinai II		
				Tokoshinai I		
				Oomagari I		
2000 B.C.		Middle Jomon				

Fig. 1. Generalized cultural chronology (after Crawford and Takamiya 1990; Suzuki 1986).

THE TOHOKU REGION

The district of Tohoku stretches approximately 500 km north to south from roughly 37° to 42° north latitude (Fig. 2). It has been described as having a climate and socioeconomic position intermediate between subtropical Japan and temperate Hokkaido (Trewartha 1965 : 367). The northern end of Tohoku terminates in two peninsulas—the Tsugaru to the west and the Shimokita to the east—and is separated from Hokkaido by the Tsugaru Strait (Numata 1974; Trewartha 1965).

The Tohoku climate is classified as continental, with marked variations in the two coastal regions. The Pacific coast is affected by the cold Oyashio current, which produces generally cooler temperatures and summer fog that often results

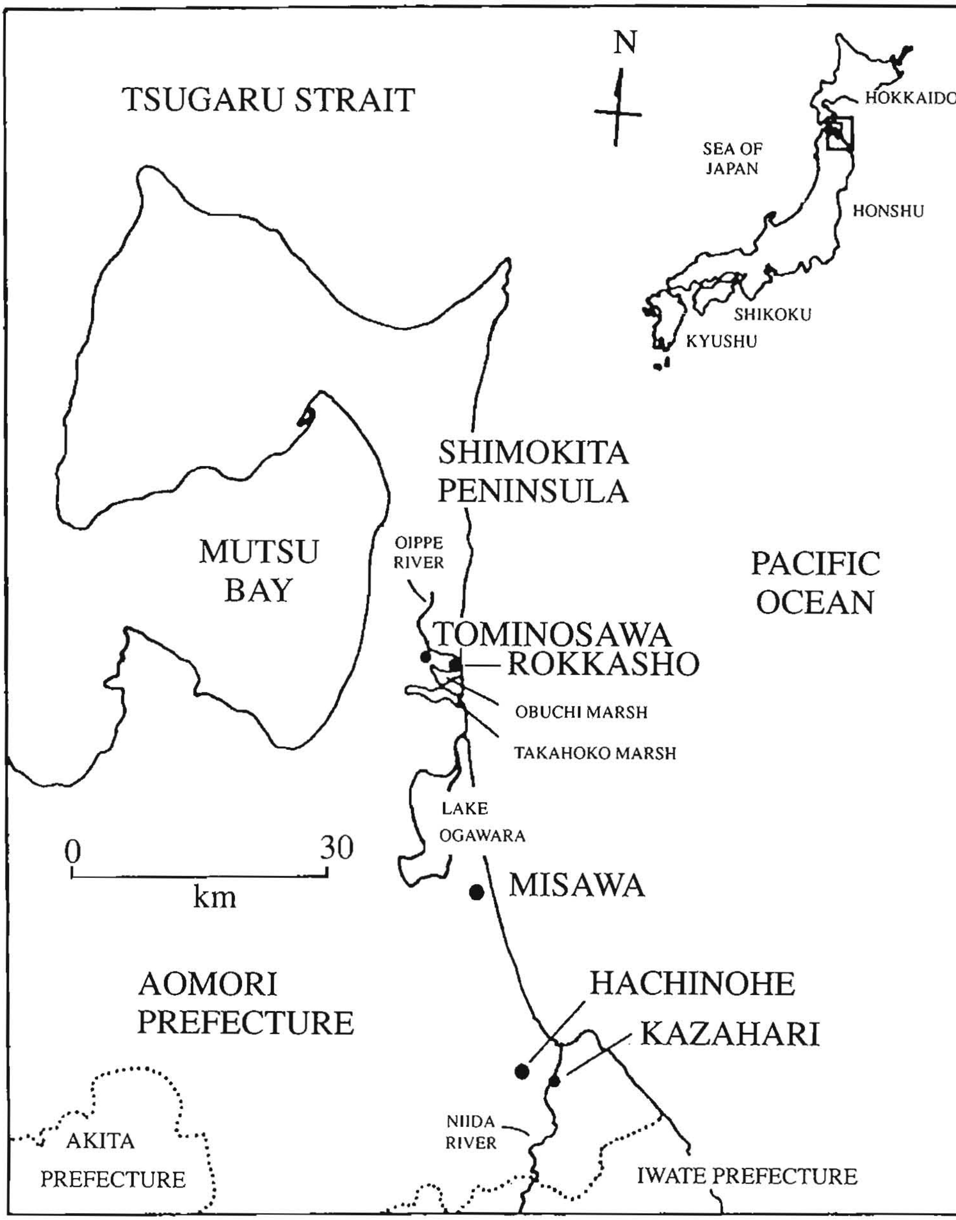

Fig. 2. Eastern Aomori Prefecture.

in rice-crop failures. The entire area of Tohoku, however, experiences mean summer temperatures of 23–24°C, which is well above the 20°C mean required for rice production (Trewartha 1965). The east–west coast dichotomy is also evident in levels of humidity and precipitation. For example, the depth and duration of snow cover is lower on the Pacific side than on the Japan Sea side. In western

Aomori Prefecture, the mean annual snowfall can be as much as 150 cm, whereas the eastern coast averages 50 cm or less (Miyawaki 1987; Numata 1974; Trewartha 1965).

The vegetation of Tohoku has elements of both subtropical and north temperate Japan. In southern Tohoku, a few outlier communities of evergreen broad-leaved forests can be found, particularly along the eastern and western coastlines. Species including *Persea thunbergii*, *Camellia japonica*, *Neolitsea sericea*, *Aucuba japonica*, *Eurya japonica*, and other evergreen trees and shrubs persist as far north as central Iwate, on the east, and central Akita, on the west coast. Apart from these and a few other outliers, Tohoku and the Oshima Peninsula of southwestern Hokkaido are covered by deciduous broad-leaved forests dominated by beech (*Fagus crenata*). Other major components of these beech forests are *Quercus mongolica* var. grosseserrata, *Acer mono*, *A. sieboldianum*, *A. japonicum*, *Acanthopanax sciadophylloides*, *Carpinus laxiflora*, *Tilia japonica*, *Prunus nipponica*, *Sorbus commixta*, *S. alnifolia*, *Fraxinus lanuginosa*, and *Ostrya japonica* (Miyawaki 1987; Ohwi 1965). Mountainous areas of Tohoku are covered by subarctic coniferous forests dominated by spruce (*Picea jezoensis*), hemlock (*Tsuga diversifolia*), and fir (*Abies veitchii* and *A. mariesii*) (Numata 1974).

The beech forests of the eastern and western coasts of Tohoku have characteristic elements determined largely by the extent of winter snowfall (Miyawaki 1987). On the western Japan Sea side, the relatively deep annual snowfall acts to protect the underlying vegetation, so *F. crenata* does extremely well in this environment. In this area, beech is associated with *Aucuba japonica* var. *borealis*, *Ilex leucoclada*, *I. crenata* var. *paludosa*, *Cephalotaxus harringtonia*, *Camellia rusticana*, and other evergreen shrubs. Conversely, the drier Pacific side receives less snowfall and *F. crenata* does not do as well: trees are shorter and produce smaller fruits. Other species characteristic of the eastern coast include *Fagus japonica* (absent in northern Tohoku), *Acer palmatum*, *Q. mongolica* var. *grosseserrata*, and *Betula schmidtii* (Miyawaki 1987). These regional differences have affected the nature of present-day agriculture in the area, and the implications for prehistoric cultivation are discussed below.

SAMPLING AND QUANTIFICATION OF CHARRED PLANT REMAINS

The fieldwork for this study was carried out using standard archaeobotanical recovery techniques that involve the use of flotation. Archaeological soil samples were processed using two SMAP-type devices (Watson 1976), one of which was designed by Crawford (1988). A second apparatus, known as "Project Seeds Model Type-1," is similar to the first, except that it is designed to process soil samples less than 20 liters in volume (see D'Andrea 1992 for a more detailed discussion of this equipment).

Sampling at both Tominosawa and Kazahari concentrated on pithouse floor deposits. Several workers have considered the processes of pithouse deposition and formation. The method of flotation sampling used by Crawford (1983) at Kameda Peninsula Middle Jomon pithouses attempted to differentiate specific depositional events. At Usujiri B and other sites in the Kameda Peninsula, sediments associated with pithouses are referred to as "X" levels. This category is divided into five sections: X1 refers to the uppermost fill layer that covers all pithouses in a site; X2 and X3 include sediments that accumulated and were dumped into the pithouse depression and those that fell in after abandonment; X4 includes floor fill at the perimeter of the pithouse, consisting of debris pushed out of the center of the pithouse floor or washed into the depression as the house collapsed; and XY refers to middens found in the area between pithouses (Bleed et al. 1979; Crawford 1983).

Kobayashi (1974) has made some interesting observations on depositional sequences observed in Jomon pithouses, based on the character and distribution of ceramics. He recognizes six patterns of discarded pottery, four of which apply to pithouses (A, B, C_1 and C_2). A typical depositional history of a pithouse is described as the Fukiage Pattern (Kobayashi 1974 : 165), in which the following sequence of events takes place:

1. Pit dwelling is constructed
2. Bits of pottery and other debris become incorporated into the floor (C_2 pattern)
3. House is abandoned
4. Depression becomes infilled
5. Discarded pots are thrown into the depression
6. Other types of debris, such as shell, are deposited
7. Infilling continues until the dwelling is almost invisible
8. Humus layer completely covers the dwelling

Kobayashi (1974) has used the nature and distribution of ceramic artifacts in his formulation of a depositional sequence for pithouses. Similarly, other researchers (e.g., Hillman 1981; Jones 1985) have suggested that the most reliable indicator of depositional events in a specific context is the nature of the artifacts recovered, including assemblages of charred plant remains. In an effort to sample Kobayashi's (1974) C_2 pattern, the lowest 5–10 cm level of each pithouse floor at both Tominosawa and Kazahari were sampled in 50 × 50 cm subunits and later examined for archaeobotanical remains. The pithouse floor deposits were targeted because these are probably contemporary with the final occupation of the pithouses, and overlying levels may be the result of later infilling. As a result, the nature and distribution of charred plant remains may reflect the depositional factors operating during the occupation of the pithouse in a manner similar to what Kobayashi (1974) concluded for ceramics. Using Crawford's (1983) terminology, the sediments sampled from both sites fall into the X2, X3, and X4 categories, and he reports generally higher seed concentrations and seed clusters in these levels at Hamanasuno.

In selecting methods of quantification, the nature of samples recovered precluded the use of some measures because of low seed counts and a lack of comparative archaeobotanical data in northeastern Aomori. Because depositional factors in context formation are of interest in this study, density (number or weight of charred remains per sediment volume) is the method of quantification employed. Ratios involving charred material and sediment volume data may be useful in testing assumptions regarding deposition and preservation, and may indicate intensity of burning activity (Miller 1988 : 73–74).

TOMINOSAWA

Tominosawa is a large Middle Jomon village located on the east coast of the Shimokita Peninsula in a rural-industrial area near Rokkasho (Fig. 2). It is situated south of the Oippe River on the coastal plains of eastern Shimokita, which extend as far south as Hachinohe City. The extreme northern end of the Shimokita Peninsula is composed of hard rock hills and volcanoes. This region is joined to the Kitakami Highlands on the main part of Honshu by the Sambongi Uplands. This plain is roughly 1600 km^2 and is made up of fluvial and marine sediments into which rivers have incised relatively wide floodplains. Along the eastern shoreline, a series of poorly drained lowlands have developed behind coastal beach ridges and dunes. Although there has been considerable land reclamation undertaken in this area, large swampy localities such as the Obuchi and Takahoko marshes persist (Fig. 2) (Trewartha 1965). Tominosawa is located at the southern edge of the rocky volcanic highlands of northern Shimokita, and as a result the large expanse of the Sambongi Plain can be viewed southward toward the low-lying marshlands. The vegetation surrounding the site is highly disturbed, and most of the lowland area is covered by open meadows and grasslands dominated by *Phleum pratense* (Miyawaki 1987).

Tominosawa was the focus of numerous occupations dating to the end of the Middle Jomon period (Miyage 1989: pers. comm.). Features at the site include circular pithouses, on the order of 4 × 5 m, as well as substantial, sometimes flask-shaped storage pits and smaller structures of unknown function. Unfortunately, detailed maps showing the extent of the site and data pertaining to the number of pithouses and features excavated are not available.

Sampling for flotation was carried out at a number of locations at Tominosawa; however, this paper will concentrate on samples recovered from Pithouse 87 (Fig. 3). The entire pithouse floor was subdivided into 82 50 × 50 cm squares, and sampling was carried out in 73 of these subunits. A total of 48 subunits was analyzed for charred plant remains, representing 66 percent of the entire pithouse floor. The samples obtained from the pithouse amount to 1122 l of sediment, and recovered charred plant remains are summarized in Figure 4 and Table 1.

Tominosawa Archaeobotanical Remains

Although there are no comparative Middle Jomon archaeobotanical data from Aomori, extensive work has been completed on roughly contemporary sites in southwestern Hokkaido. In the Hakodate area, sampling for flotation was carried out at four sites dating from the Initial to the early Late Jomon (Crawford 1983). The Early Jomon contexts at Hamanasuno and the Middle Jomon deposits at Usujiri B are particularly relevant to this discussion of the Tominosawa samples.

The remains of specimens comprising nine genera were recovered from Pithouse 87, including two species of nut (walnut and acorn). The largest category of seeds is the unidentifiable seed fragments, followed by grains of weedy grasses and forbs, other seeds, unknown seeds, and fleshy fruit seeds (Table 1, Fig. 4). This spectrum of remains is similar to that recovered from the site of Usujiri B. For example, from Pit 1 in House 10 at Usujiri B (Saibesawa VII, Middle Jomon), the grains of weedy grasses and forbs (37 percent) dominate flotation samples, followed by sumac (9 percent), and fleshy fruit seeds (8 percent) (Craw-

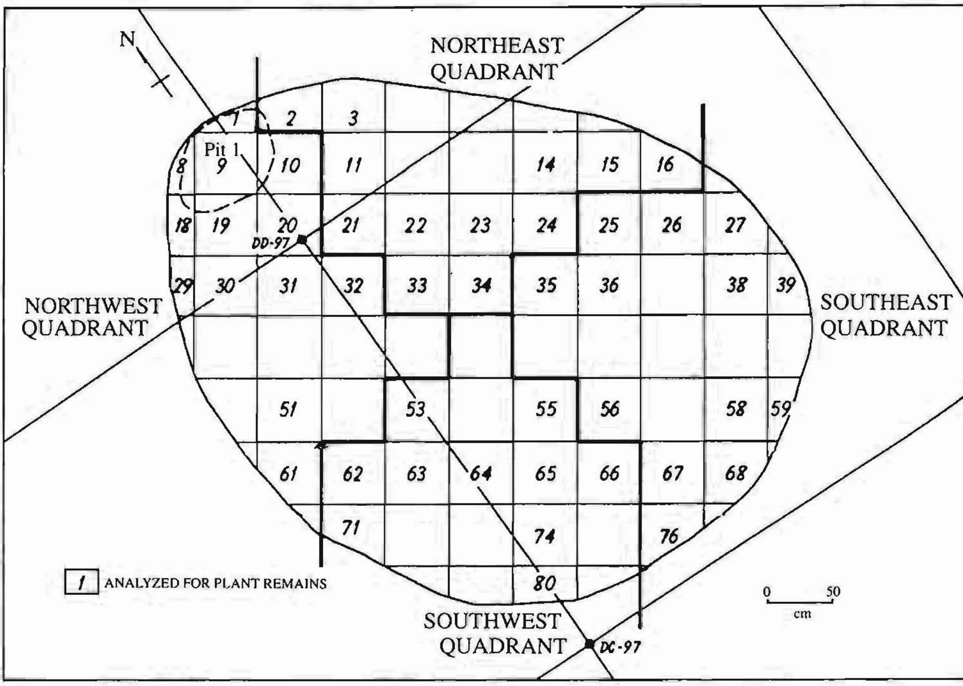

Fig. 3. Pithouse 87 at Tominosawa, Aomori.

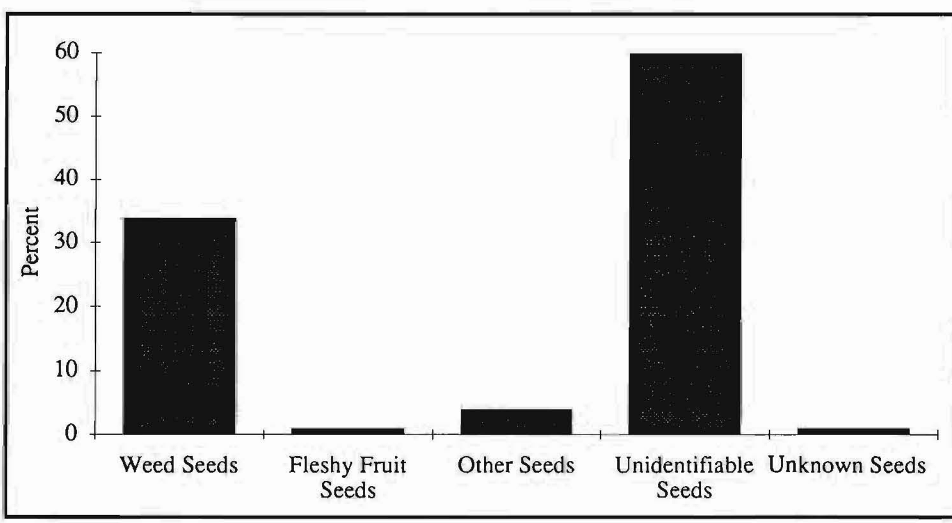

Fig. 4. Archaeobotanical remains from Tominosawa Pithouse 87, Aomori.

ford 1983). In Pithouse 87 floor samples at Tominosawa, the achenes of knotweeds account for 80 percent of the total weed seed count, with identified species including *Polygonum lapathifolium* and *P. lapathifolium*-type. Unknown types of knotweed include *P.* Type 1, *P.* Type 3, *P.* Type 4, and *P.* Type 5a (see

Table 1. Tominosawa Pithouse 87 Archaeobotanical Remains

COMMON NAME	SCIENTIFIC NAME	NUMBER (WEIGHT g)	PERCENT OF TOTAL NO.
Weeds			34
Green foxtail	*S. italica* ssp. *viridis*	1	
Barnyard grass	*E. crusgalli*	13	
Panicoid grass	Paniceae	1	
Sheep sorrel	*Rumex*	3	
Knotweeds	*P. lapathifolium*	2	
	P. lapathifolium-type	7	
	Polygonum	3	
	Type 1	58	
	Type 3	1	
	Type 4	5	
	Type 5a		
Aster family	cf. Asteraceae	1	
Total Weeds		96	
Fleshy Fruits			1
Elderberry	*Sambucus*	3	
Total Fleshy		3	
Other Seeds			4
Prickly ash	*Zanthoxylem piperitum*	1	
Sumac	*Rhus*	10	
Total Other		11	
Unknown Seeds		4	1
Unidentifiable Seeds		165	59
Total Seeds		279	
Walnut shell	*Juglans ailanthifolia*	(0.2)*	
Acorn cotyledon	*Quercus*	(4.00)*	

* Light fraction actual weight.

D'Andrea 1992 for identification criteria). The wild grass grains recovered are all assignable to the tribe Paniceae, with two species identifications of *Setaria italica* ssp. *viridis* and *Echinochloa crusgalli*. Large numbers of barnyard grass grains were recovered from late Middle Jomon contexts in House 10 at Usujiri B, and an increase in caryopsis (grain) size through time suggests that this species was cultivated. The length-to-width ratios of the Tominosawa barnyard grass caryopses fall into the lower size-range of those reported from Hamanasuno and Usujiri B, so if cultivation of these grasses took place at Tominosawa, it did not result in an increase in caryopsis size. Other seeds included *Rhus* and the aromatic herb *Zanthoxylem piperitum*. *Rhus* seeds were common at Usujiri B, sometimes occurring in clusters (Crawford 1983), although no such pattern was observed in Pithouse 87.

The density of wood charcoal and seeds among the house floor subunits in Pithouse 87 is illustrated in Figure 5. It should be mentioned that the *y*-axis in this graph includes two units of measurement: number of seeds per liter (No./l) and grams of wood charcoal per liter (g/l). These two elements should not be directly compared, but, rather, the relative abundances of seeds and wood charcoal across the subunits may be informative. The floor subunits are divided into northeast, northwest, southeast, and southwest quadrants, and these locations are

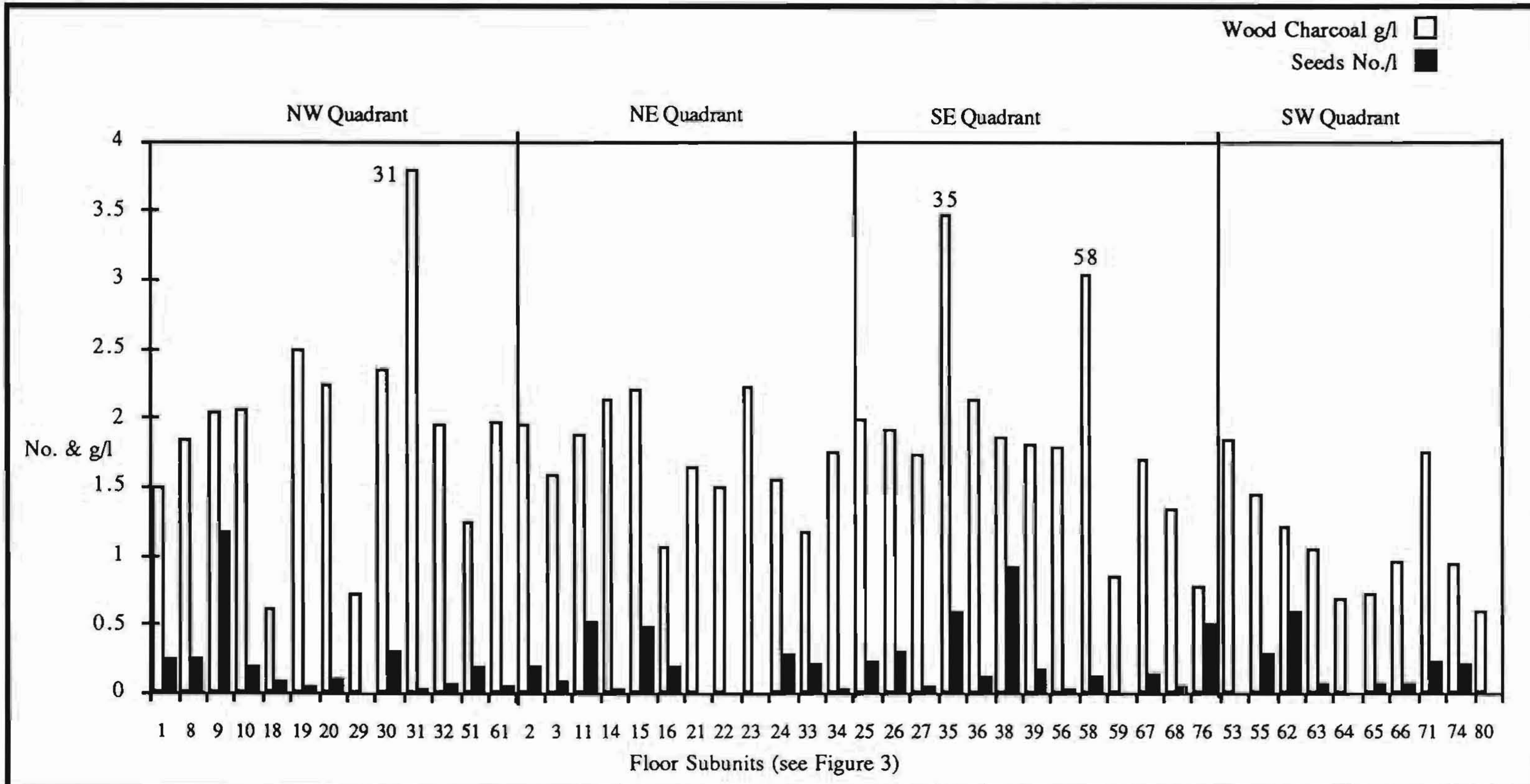

Fig. 5. Density of wood charcoal and total seeds in Tominosawa Pithouse 87, Aomori.

illustrated in Figure 3. The highest concentration of wood charcoal is found in subunits 31, 35, and 58. The highest concentrations of seeds (the majority of which were the grains of weedy grasses and forbs) are found in subunits 9, 38, and 62.

As is evident in Figure 5, concentrations of wood charcoal and seeds are most pronounced in the northwest (especially subunits 9 and 31) and southeastern quadrants (especially subunits 35 and 58). These higher concentrations occur in both floor interior and edge locations. Although the absolute seed count is not high, this pattern in the northwest quadrant may indicate a disposal or activity area, perhaps in association with Pit 1. However, the remains in Pit 1 itself do not differ in character or density from the surrounding floor-fill deposits. At Usujiri B, the floor-fill samples appeared to be rich in grain seeds and some fleshy fruit seeds. In Early Jomon pithouses at Hamanasuno, a higher concentration of weed seeds is associated with pits and hearths, and fleshy fruit and other seeds are distributed evenly throughout the pithouse floor. This may indicate that different processing techniques applied to fleshy fruits compared to grain seeds, which are often parched prior to consumption (Crawford 1983). In Pithouse 87 at Tominosawa, fleshy fruit and other seeds are found neither in Pit 1 nor in the nearby floor subunits, and they appear to be thinly scattered over the pithouse floor subunits. This pattern may be similar to that at Hamanasuno, but the number of these seeds is too small to be conclusive. Unfortunately, at the time of sampling, the hearth and additional pits and features of Pithouse 87 had not yet been excavated.

Although this sample of seeds from Tominosawa is small, the spectrum is similar to that of the Middle Jomon site of Usujiri B (Crawford 1983). In both regions, the low concentrations of seeds are puzzling. One might expect more evidence of plant use, either by gathering or cultivation, at these large Middle Jomon sedentary village sites. Unfortunately, the low frequencies of seeds and plant remains recovered at Tominosawa, and the absence of information on hearths and other features, do not allow firm conclusions to be reached regarding their distribution over the floor of Pithouse 87.

Middle Jomon Subsistence

Many researchers have explored the possibility of Middle Jomon plant cultivation (e.g., Nishida 1983; Sakazume 1961; Sasaki 1971), but direct evidence in support of these hypotheses was unavailable when the studies were undertaken. Subsistence practices of Middle Jomon and later cultures of northeastern Japan are assumed to have focused on both inland and marine resources. Specific geographic areas have been identified as areas of specialization. For example, in the Kanto area, inner-bay fishing is thought to have been the predominant subsistence activity, whereas in northeastern Tohoku, deep-sea fishing is thought to have been important (Ikawa-Smith 1980: 139). However, recent research has indicated that attempts to characterize subsistence in the absence of palaeoethnobotanical data may result in an incomplete view of ancient economies. When archaeobotanical research has been carried out, it becomes apparent that other resources, including cultivated plants, must be considered a part of Middle Jomon subsistence. In the Kameda Peninsula, for example, there are no shell middens dating to the Middle Jomon. This, in addition to the nature of plant remains recovered, suggests that populations were involved in some form of plant husbandry in addition to foraging (Crawford 1983).

The archaeobotanical samples recovered from late Middle Jomon contexts in Aomori are not extensive, and it is difficult to generalize about subsistence based on these remains alone. However, if the Tominosawa data are compared with Early and Middle Jomon archaeobotanical evidence from sites on the Kameda Peninsula (Crawford 1983; Crawford et al. 1976), a more comprehensive discussion of Middle Jomon subsistence is possible.

The distribution of plant remains in Tominosawa Pithouse 87 does not indicate clusters or activity areas, except for a possible concentration of charred plant remains in the northwest and southeast quadrants. Without the location of a hearth and other features, it is difficult to speculate on the significance of the distribution of these remains. These shortcomings notwithstanding, the spectrum of seeds recovered from pithouse floor deposits can be expected to reflect a long-term rather than a seasonal representation of plant use. It is assumed that seeds were brought into the house either because they were utilized directly or were indirectly carried in through other activities. Within a pithouse, the effect of background seed rain should be reduced. Since there is little in the archaeological contexts to distinguish direct from indirect sources of seeds, comparisons with data from other Middle Jomon sites and the ethnographic record are necessary.

In roughly contemporaneous Middle Jomon occupations in the Kameda Peninsula, 45 percent of the 6087 seeds recovered were made up of 14 consistently appearing taxa, including amur corktree, barnyard grass, blackberry, chenopod, dock, elderberry, grape, knotweed, sumac, silvervine, and *Aralia*. In addition, the distribution of these species throughout the contexts (house floors, hearths, and pits) suggests that they were utilized in some manner. For example, some species, such as knotweeds (*P. lapathifolium* and *P. cuspidatum*) were found in distinct clusters. This pattern suggests that the seeds were not accidental inclusions but are representative of subsistence activities (Crawford 1983). Further support that these remains may represent food residues comes from ethnobotanical literature on the Ainu. Ethnographic records show that the Ainu consumed many of the plants recovered archaeologically, such as walnut, wild grape, acorn (Watanabe 1972), *P. cuspidatum*, *Zanthoxylem piperitum* (Ohwi 1965), amur corktree (Crawford 1983), *Aralia cordata*, knotweeds, and blackberry (Kindaichi 1941).

Middle Jomon populations, through the activities of constructing and living in sedentary settlements, created anthropogenic landscapes that provided excellent habitats for weedy annual and perennial grasses, forbs, and fleshy fruit species such as blackberry, grape, silvervine, *Sorbus*, and *Aralia*. These species formed the major component of the Kameda Peninsula site archaeobotanical samples and are also common in contexts sampled at Tominosawa. Many of these plants would have grown in disturbed areas rather than in mature beech forests, which were more prevalent in earlier periods. In the Kameda sites, percentages of seeds such as barnyard grass, dock, chenopod, and knotweeds increase from Early to Middle Jomon times. Crawford (1983, 1992*b*) suggests the presence of gardening in the Middle Jomon based on evidence from the Hamanasuno and Usujiri B sites in southwestern Hokkaido. Over a 4000-year period, the caryopsis (grain) size of barnyard grass specimens at these sites is shown to increase steadily through time.

This may indicate that cultivation was taking place locally. Barnyard grass is the wild ancestor of domesticated Japanese barnyard millet (*Echinochloa utilis*) (Yabuno 1966: 320–321). Additional evidence for Middle Jomon plant husbandry comes from the Usujiri B site, where a recent reexamination of grass caryopses has demonstrated the presence of domesticated foxtail millet and Japanese barnyard millet. These gardened plants may have eventually displaced nuts as a major food source (Crawford 1983, 1992*b*). Unfortunately, the sample of barnyard grass at Tominosawa is too small (n = 13) to confirm the presence of plant husbandry. However, it is difficult to visualize populations inhabiting these sedentary Middle Jomon communities without making relatively intensive use of local plant species or introducing some degree of anthropogenic impact into local environments.

The focus on marine resources often described for northeastern Japan during the Jomon is not apparent in the Kameda Peninsula. In Hokkaido, faunal remains from Hamanasuno and Yagi suggest a dependence on a mixture of sea and land mammals (Bleed et al. 1989; Crawford 1983). Early Jomon faunal remains at Yagi indicate the exploitation of a variety of large land and sea mammals, small mammals, birds, and fish, all of which were procured within a short distance of the site. These data indicate that the inhabitants of Yagi probably had a high degree of residential stability (Bleed et al. 1989; Crawford 1992*b*). Unfortunately, acidic soil conditions at Tominosawa resulted in the preservation of very few faunal remains, and it is unknown whether a similar exploitation pattern was in existence during the Middle Jomon. The Kameda sites show a reduction through time in the quantity of nut remains. Initial Jomon components of the Nakano B and Hakodate Airport sites produced larger quantities of nuts, while Early to Final Jomon sites in the area (Hamanasuno, Usujiri B, and Locality 4, Hakodate Airport) did not produce much in the way of nut remains. Instead, subsistence at these localities may have emphasized the collection of weedy grasses and cultivation of foxtail millet (*Setaria italica* ssp. *italica*), Japanese barnyard millet, barnyard grass, and buckwheat (*Fagopyrum esculentum*) (Crawford 1983, 1992*b*). Similarly, few nut remains were recovered from Tominosawa, and it is possible that the inhabitants of this site also procured weed seeds. More sampling of Middle Jomon contexts in Tohoku is necessary to confirm this pattern.

KAZAHARI

The Kazahari site is located near Hachinohe City, east of the Niida River on the southern edge of the Sambongi Uplands (Fig. 2). The occupation of this locality spanned Late Jomon and Heian times (Fig. 1). The site is located on an elevated point of land that provides a spectacular view of the surrounding river valley. Although it is presently covered with rice paddies, this valley is the former floodplain of the Niida River. Along the higher margins of the valley, secondary forests are presently dominated by oaks, especially *Q. dentata* (D'Andrea 1992). The majority of flotation samples from Kazahari were taken from two structures, Pithouses 32 and 37, which date to the Tokoshinai IV and Fukurashima phases, respectively. As is evident in Figure 1, the Late Jomon of Aomori is dominated by the Tokoshinai ceramic phases, of which Tokoshinai IV appears toward the close of the period. In the following Final Jomon, Obora ceramic phases persist over much of Tohoku, but by the end of the period, a north–south dichotomy develops with Fukurashima appearing in the south. This phase is present in the north as well, but it is not as clearly defined (Kudo: pers. comm. 1989; Suzuki 1986).

Pithouse 32 is a large Late Jomon pithouse measuring 16 × 15 m (Fig. 6). The floor was excavated in a manner identical to that described for Pithouse 87 at Tominosawa, and deposits produced exclusively Tokoshinai IV ceramics. Sampling was not carried out in the southwest part because the sterile substrate had already been exposed. Of the 208 subunits mapped in total, 76 were sampled for flotation, representing approximately 37 percent of the entire house. Of the 76 subunits, 49 were analyzed for archaeobotanical remains, representing approximately 24 percent of the entire pithouse floor. In addition to the floor, 20 pits and the hearth area were sampled for flotation (Fig. 6). Of the 20 pits, 11 were of unknown function (possibly including postholes, storage, and other types of pits) and 10 appeared to be postholes. All of the sediment from the postholes was saved for flotation, while 50 percent of the pits were sampled. In total, 1586 l of sediment were analyzed from Pithouse 32.

Pithouse 37 dates to the Final Jomon and produced Fukurashima phase ceramics (Fig. 1). It was only half exposed, but the floor fill and pits were sampled in a manner similar to that used in Pithouse 32 (Fig. 7). Of the 76 mapped subunits, 53 were collected for flotation, representing approximately 72 percent of the exposed half of the house. Of the 53 collected subunits, 32 were analyzed in their entirety, representing roughly 40 percent of the structure (877 l). In addition, eight pits were sampled, of which three were of unknown function and five appeared to be postholes. Except for the postholes and Pit F, which were sampled in their entirety, 50 percent of the remaining pits were subsampled for flotation.

Pithouse 32: Tokoshinai IV Archaeobotanical Remains

A total of 14 genera (including acorn and walnut) have been identified in Pithouse 32, three of which represent domesticated plants. Unidentifiable fragments account for the largest category of seeds, followed by weeds, fleshy fruit seeds, cultigens, other seeds, and unknown seeds (Table 2; Fig. 8). The weed seeds in Pithouse 32 are dominated by species of *Polygonum* with two identifiable species represented, *P. lapathifolium* and *P. lapathifolium*-type, in addition to unknowns *P.* Type 1 and Type 3. The next most common specimens are the grasses, particularly the millets, with two identified species including *Echinochloa crusgalli* and *Setaria italica* ssp. *viridis*. Additional weed species present are *Rumex* and *Chenopodium*. The fleshy fruits include *Sambucus*, followed by *Actinidia*, *Rubus*, and *Vitis*, while other seeds represented are *Zanthoxylem piperitum* and an unknown legume (Fabaceae). The cultigens are represented by rice (*Oryza sativa* var. *japonica*), foxtail, and broomcorn millet (*Panicum miliaceum*).

The presence of cultigens at this northern locality dating to the Tokoshinai IV phase is rather unexpected. Late Jomon rice is present in southwestern Japan (e.g., Kasahara 1982, 1984; Kotani 1972; Nishida 1976; Tsunoda and Watanabe 1976; Yoshizaki 1995), but prior to this study, it was not known to be present in Tohoku until the Final Jomon Obora A phase (Fig. 1) (Crawford 1992*a*; Suto

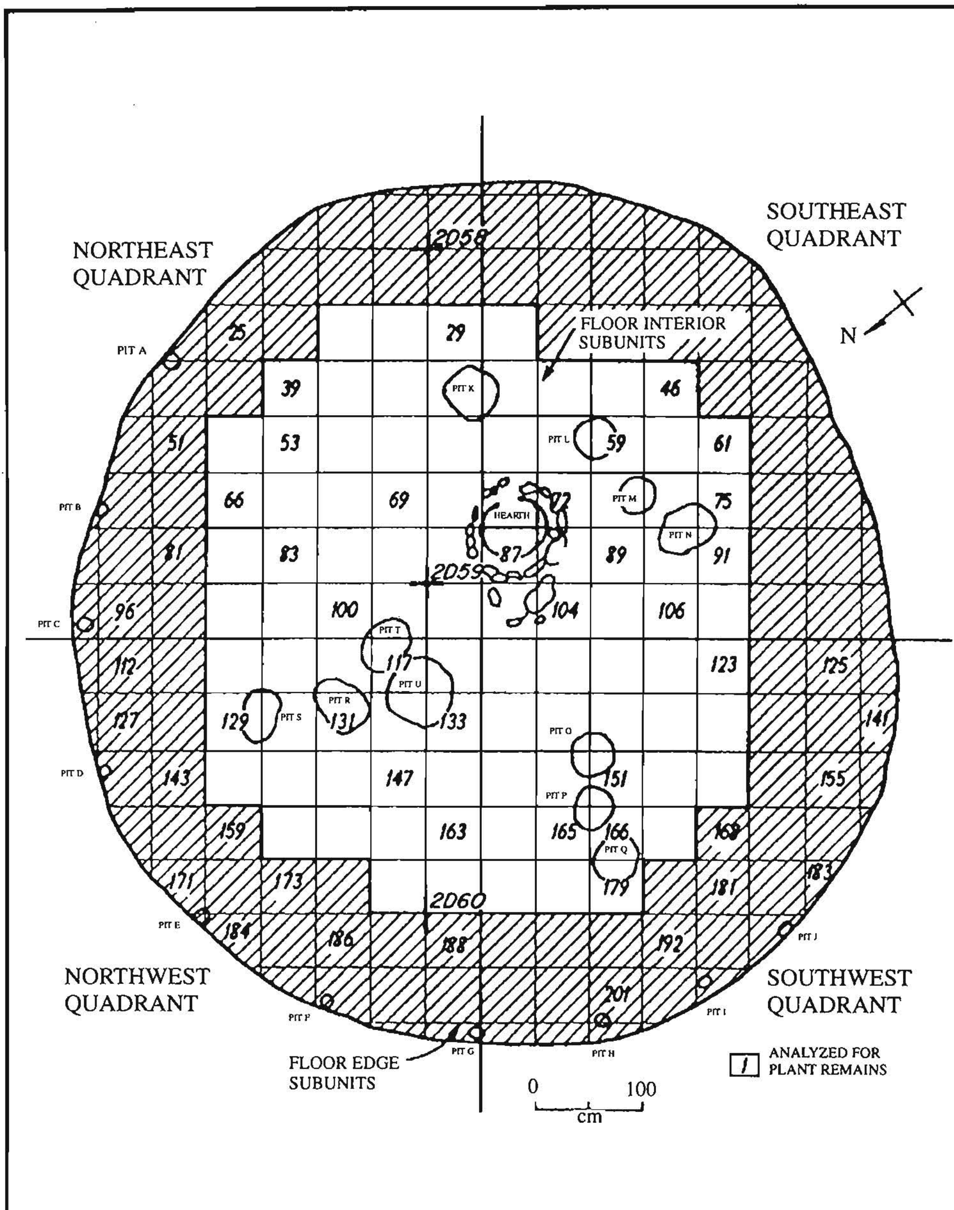

Fig. 6. Pithouse 32 at Kazahari, Aomori.

1988). Two of the rice caryopses were radiocarbon dated at the University of Toronto IsoTrace Radiocarbon Laboratory, with resulting age determinations of 2540 ± 240 B.P. (TO-2202) and 2810 ± 270 B.P. (TO-4086). The mean dendro-calibrated ages are 787 cal. B.C. and 925 cal. B.C. (D'Andrea et al. 1995), with a combined mean of 810 B.C. The calibrated ages suggest that the grains may be somewhat younger than the Late Jomon, but they are more consistent with Tokoshinai IV than with later Fukurashima occupations of the site. These results

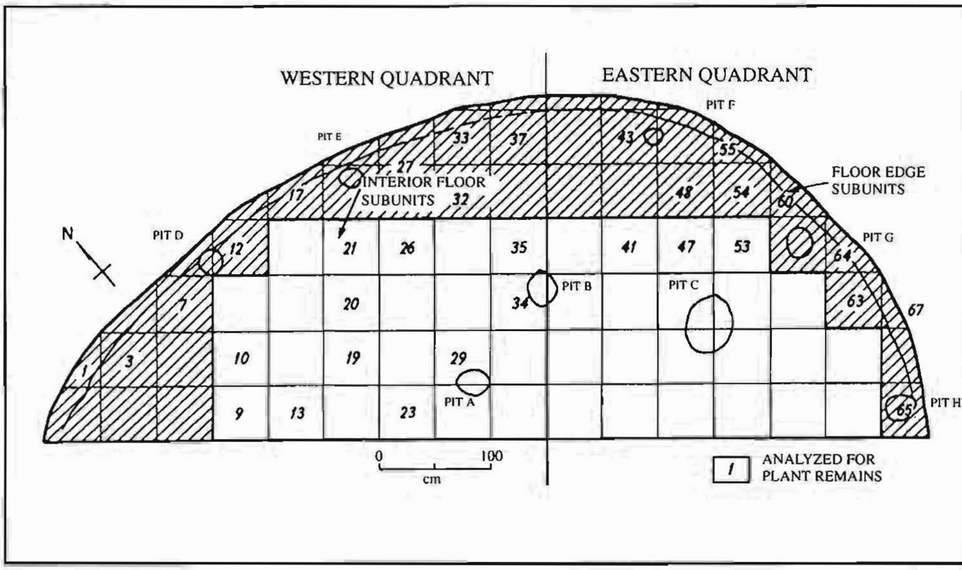

Fig. 7. Pithouse 37 at Kazahari, Aomori.

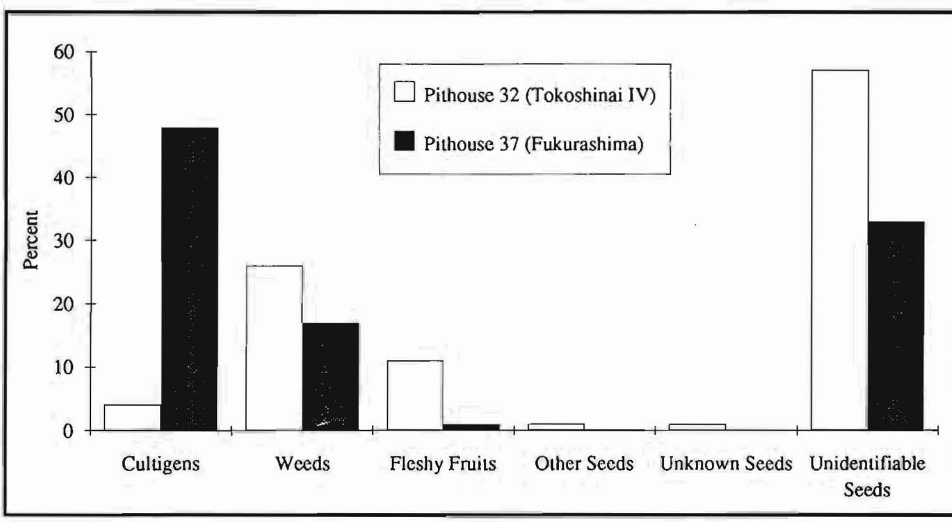

Fig. 8. Archaeobotanical remains from Kazahari Pithouses 32 and 37, Aomori.

indicate the presence of rice in northern Tohoku at a time earlier than was previously thought. As such, the Kazahari rice dates provide supporting evidence for the rapid spread of rice, and perhaps its cultivation, into northeastern Japan (Barnes 1993; Crawford 1992*b*; D'Andrea et al. 1995). Broomcorn millet has been identified in Ezo–Haji contexts in southwestern Hokkaido, but its prehistoric role in Japan remains uncertain (Crawford 1992*a*). The one specimen from Kazahari is insufficient to allow speculation on its role in Tokoshinai IV economy. The foxtail millet provides additional evidence for the early presence of this

TABLE 2. KAZAHARI PITHOUSE 32 ARCHAEOBOTANICAL REMAINS

COMMON NAME	SCIENTIFIC NAME	NUMBER (WEIGHT g)	PERCENT OF TOTAL NO.
Cultigens			4
Rice	*Oryza sativa* var. *japonica*	7	
Foxtail millet	*Setaria italica* ssp. *italica*	7	
Broomcorn millet	*Panicum miliaceum*	1	
Total Cultigens		15	
Weeds			26
Green foxtail	*Setaria italica* spp. *viridis*	4	
Foxtail grass	*Setaria*	2	
Barnyard grass	*Echinochloa crusgalli*	10	
Panicoid grass	Paniceae	13	
Grass family	Poaceae	8	
Sheep sorrel	*Rumex*	1	
Knotweeds	*P. lapathifolium*	5	
	P. lapathifolium-type	34	
	Polygonum	3	
	Type 1	10	
	Type 3	2	
Goosefoot	*Chenopodium*	2	
Total Weeds		94	
Fleshy Fruits			11
Bramble	*Rubus*	1	
Grape	*Vitis*	1	
Silvervine	*Actinidia*	7	
Elderberry	*Sambucus*	31	
Total Fleshy		40	
Other Seeds			1
Legume	Fabaceae	1	
Prickly ash	*Zanthoxylem piperitum*	3	
Total Other		4	
Unknown		3	1
Unidentifiable		211	57
Total Seeds		367	
Nuts			
Walnut shell	*Juglans ailanthifolia*	(123.39)*	
Acorn cotyledon	*Quercus*	(6.06)*	

* Estimated heavy and light fraction weight.

cultigen in the northeast. It is known from Middle Jomon levels (4000–3800 B.P.) at Usujiri B (Crawford 1992*b*), and possible milletlike pollen has been recovered in Late Jomon levels (3000 B.P.) at Ukinuno Pond (Tsukada 1986). The only additional evidence for Late Jomon domesticates in the northeast is buckwheat pollen from the Kyunenbashi site, Iwate (Yamada 1980).

The relatively large number of contexts sampled from Pithouse 32 allows for an analysis of the distribution of seeds and archaeobotanical components throughout the structure. Although the entire pithouse floor was excavated as a unit, an attempt was made to isolate the house floor periphery from the interior units. The house floor was divided into quadrants (Fig. 6) in an attempt to isolate areas of concentration. The plant remains recovered from the floor subunits were then compared to those found in the postholes, pits, and hearth deposits.

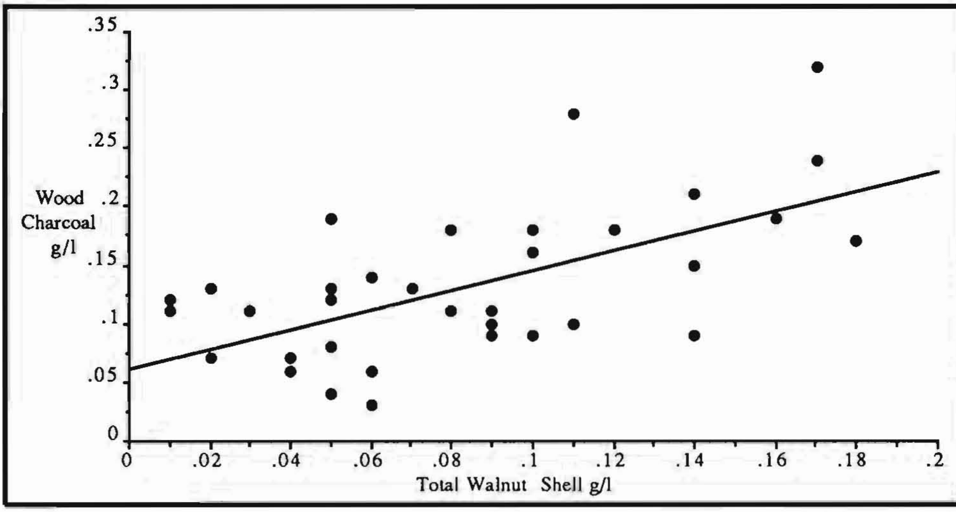

Fig. 9. Wood charcoal and walnut shell density correlation in Kazahari Pithouse 32, Aomori.

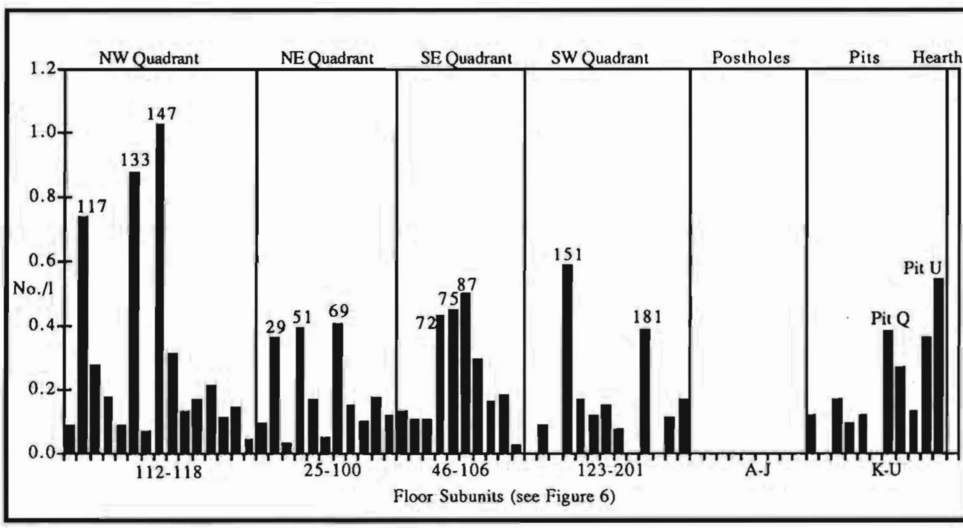

Fig. 10. Density of seed remains in Kazahari Pithouse 32 quadrants, Aomori.

The two major archaeological components, wood charcoal and walnut shell, are scattered somewhat evenly throughout the house. However, Figure 9 illustrates the presence of a weakly positive correlation between 92 percent[2] of the floor subunits containing wood charcoal and walnut shell. Furthermore, the absence of seed remains from the postholes (Fig. 10) is noteworthy. The sources of plant remains that accumulate in postholes are exceedingly numerous, and it should not be assumed that the residues of one activity are thus represented (cf. van Vilsteren 1984). Postholes act as accumulation areas for plant remains and other debris that are swept about the floor of a house during everyday activities. In Pithouse 32, the hearth area was, perhaps, the major source of the charred

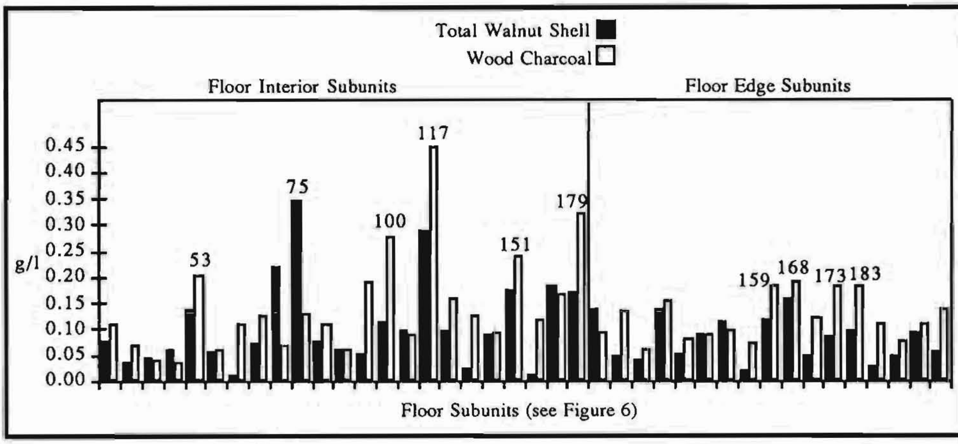

Fig. 11. Density of wood charcoal and walnut shell in Kazahari Pithouse 32 interior and floor-edge subunits, Aomori.

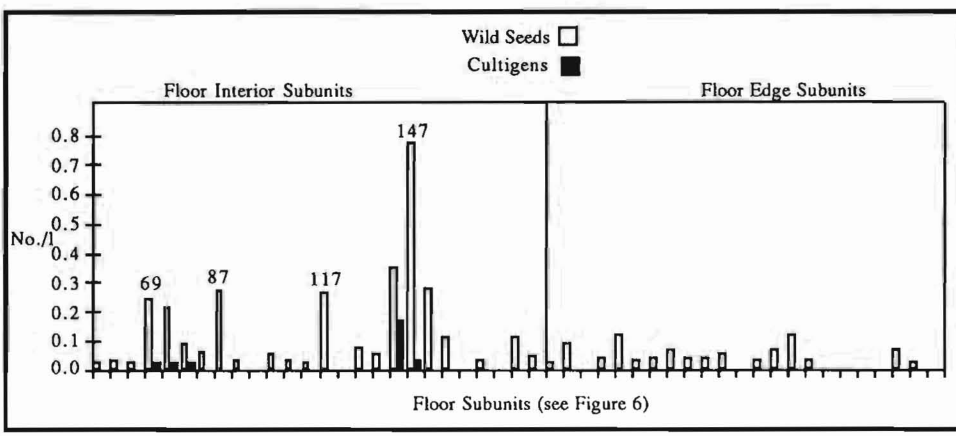

Fig. 12. Density of cultigens and wild seeds in Kazahari Pithouse 32 interior and floor-edge subunits, Aomori.

materials, which were subsequently redeposited in other sections of the pithouse. The hearth is somewhat removed from the postholes at the circumference (A–J), and it is possible that the larger and more durable remains that were swept about the floor may have more easily survived the journey to the edge of the house than did seeds. Figures 11 and 12 also illustrate that, although there is some variation in all areas, charred plant remains are present in slightly higher densities in the interior sections of Pithouse 32. This distributional pattern, and the correlation between wood charcoal and walnut shell densities, may point to the use of these two elements as fuel that later became dispersed from the hearth to outer areas through various cleanings or the intentional spreading of ashes. As this house did not burn down, it can be assumed that collapsing building materials did not contribute to the charred samples. Consequently, these remains may be a relict of the original distribution of charred plants during the use of the house prior to abandonment. This pattern of fragment distribution supports Kobayashi's (1974) classification of pithouse deposits, specifically the C_2 pattern, as representing materials incorporated into pithouse floors during the use of the dwelling. It should be kept in mind, however, that the actual number of seeds found in these concentrations low. Furthermore, at the Hamanasuno site, the opposite pattern was observed: postholes were found to contain the highest density of seeds, although some of these were located in the center of pithouses (Crawford 1983).

Pithouse 37: Fukurashima Archaeobotanical Remains

The concentration of seeds in Pithouse 37 deposits is the highest encountered in this study (Table 3; Fig. 8). A total of 1090 seeds was recovered, representing 15 genera (including walnut and acorn). The most common seeds identified were cultigens, followed by unidentifiable seed fragments, weeds, fleshy fruits, unknown, and other seeds. The cultigens include relatively large quantities of rice, followed by foxtail, broomcorn, and Japanese barnyard millet and hemp. Weed seeds are dominated by species of knotweed, primarily *Polygonum* Type 1R, followed by *Polygonum*, *P.* Type 1, *P. lapathifolium*-type, *P. lapathifolium*, *P.* Type 5, and *P.* Type 4. The remaining weeds consist of *Setaria cf. viridis*, *Setaria*, *Echinochloa crus-galli*, Paniceae, Poaceae, and *Chenopodium*. Fleshy fruit seeds include elderberry, blackberry, grape, *Aralia cordata*, and *Aralia*, while the category of other seeds includes *Zanthoxylem piperitum*.

Distributional analyses of seeds for Pithouse 37 are hampered by the fact that it is only half exposed. Nevertheless, this analysis was attempted by dividing the floor subunits into western and eastern halves (Fig. 7), and comparing these to the pits (Pits A–C) and postholes (Pits D–H). In addition, the floor was divided into interior and edge subunits. Walnut shell and wood charcoal are scattered in low quantities among all feature types, and their distribution was not correlated, as was observed in Pithouse 32. Also, no pattern is evident when the floor subunits are separated into interior versus edge subunits (Fig. 7), except that most of the higher values for wood charcoal are found in the floor-edge subunits.

Figure 13 illustrates the concentrations of wood charcoal weight and total seed count in interior and floor-edge subunits. The y-axis in this figure is similar to those of previous graphs where the number of seeds/l of sediment is used as a measure of density, whereas for wood charcoal the unit of density is g/l of sediment. There is no correlation observed in the concentration of wood charcoal and total seed densities. Similarly, when the floor-edge and interior subunits are examined, both elements appear to be randomly scattered, except for the presence of relatively higher concentrations of seeds in Pit A, Postholes D, E, F (see Fig. 14), and subunits 1, 33, 41, and 48. Except for floor subunit 41, these features represent floor-edge contexts. Subunits 1 and 33, and Pits D, E, and F are situated in a depressed area, possibly a drainage trench, that runs around the periphery of the floor edge inside the house, where seeds could easily have accumulated. On the other hand, Pit A is situated near what appears to be the center of the house (Fig. 6), and it produced a diversity of species, including 31 rice grains, 23 unidentifiable fragments, seven weed seeds, and one unknown seed. Although not visible, the hearth is likely nearby and could have contributed to

TABLE 3. KAZAHARI PITHOUSE 37 ARCHAEOBOTANICAL REMAINS

COMMON NAME	SCIENTIFIC NAME	NUMBER (WEIGHT g)	PERCENT OF TOTAL NO.
Cultigens			48
Rice	*Oryza saliva* var. *japonica*	496	
Foxtail millet	*Setaria italica* ssp. *italica*	6	
Barnyard millet	*Echinochloa utilis*	1	
Broomcorn millet	*Panicum miliaceum*	2	
Hemp	*Cannabis sativa*	1	
Indeterminate cultigen		20	
Total Cultigens		526	
Weeds			17
Green foxtail	*Setaria italica* spp. *viridis*	1	
Foxtail grass	*Setaria*	1	
Barnyard grass	*Echinochloa crusgalli*	6	
Panicoid grass	Paniceae	5	
Grass family	Poaceae	10	
Knotweeds	*P. lapathifolium*	3	
	P. lapathifolium-type	39	
	Polygonum	6	
	Type 1	5	
	Type 1R	90	
	Type 4	1	
	Type 5	3	
Goosefoot	*Chenopodium*	10	
Total Weeds		180	
Fleshy Fruits			
Bramble	*Rubus*	1	
Grape	*Vitis*	(?)1	
Silvervine	*Actinidia cf. cordata*	1	
Udo	*Aralia*	1	
Elderberry	*Sambucus*	11	
Total Fleshy		15	
Other Seeds			nil
Prickly ash	*Zanthoxylem piperitum*	2	
Total Other		2	
Unknown		4	nil
Unidentifiable		363	33
Total Seeds		1090	
Nuts			
Walnut shell	*Juglans ailanthifolia*	(31.52)*	
Acorn cotyledon	*Quercus*	(4.16)*	

* Estimated heavy and light fraction weight.

the material recovered in this pit. The emerging pattern in Pithouse 37 is that seeds appear to be concentrated in floor-edge subunits and postholes, and in the central area of the house associated with Pit A.

In examining the distribution of different seed categories in Pithouse 37, some other patterns emerge. Figure 14 indicates that cultigens are concentrated in the western part of the house, particularly in the floor-edge areas (subunits 1, 17, 33, Pits A, D, E, and F). In these locations, weed seed densities appear to be relatively low, with the highest concentrations occurring in the eastern quadrant of the

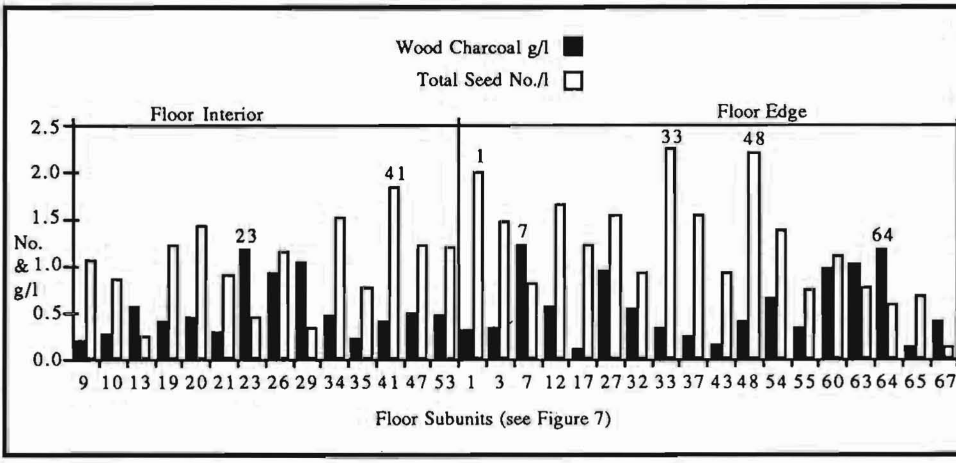

Fig. 13. Density of wood charcoal and total seeds in Kazahari Pithouse 37 interior and floor-edge subunits, Aomori.

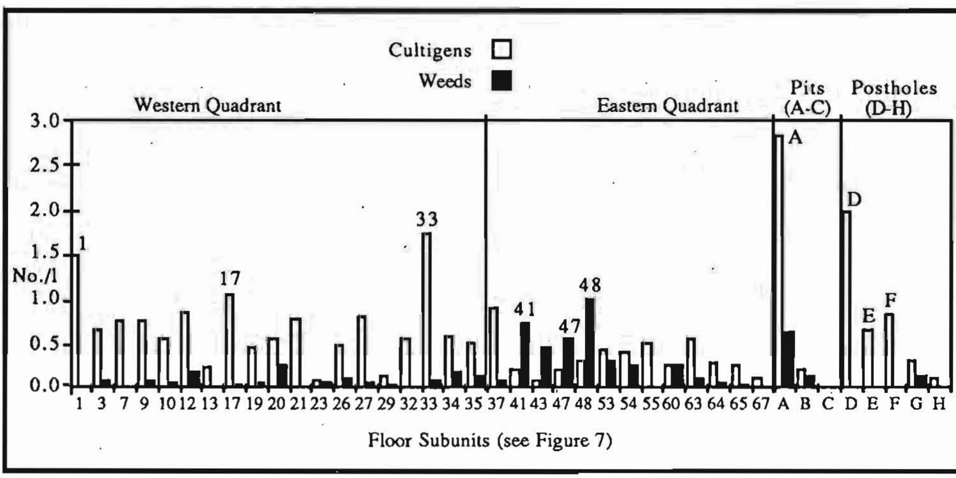

Fig. 14. Density of cultigens and weed seeds in Kazahari Pithouse 37 quadrants, Aomori.

floor fill (subunits 48, 41, and 47) and in Pit A. Postholes D, E, and F, which are located along the floor edge, have no weed seeds but show relatively high concentrations of cultigens. If only floor edges are examined, densities of weed seeds and cultigens appear to be inversely related. This observation is supported by a weakly negative correlation demonstrated in the distribution of weed seed and cultigen densities in 78 percent[3] of the floor-edge subunits (Fig. 15). The higher concentration of total seeds in floor-edge subunits may be the result of sweeping, trampling, or other depositional factors such as intentional spreading of ash along floor edges and/or water flow through a trench found to occur sporadically along the periphery of the pithouse floor. A similar trench or depressed area was not observed in Pithouse 32. If sweeping, deposition by water, or intentional spread-

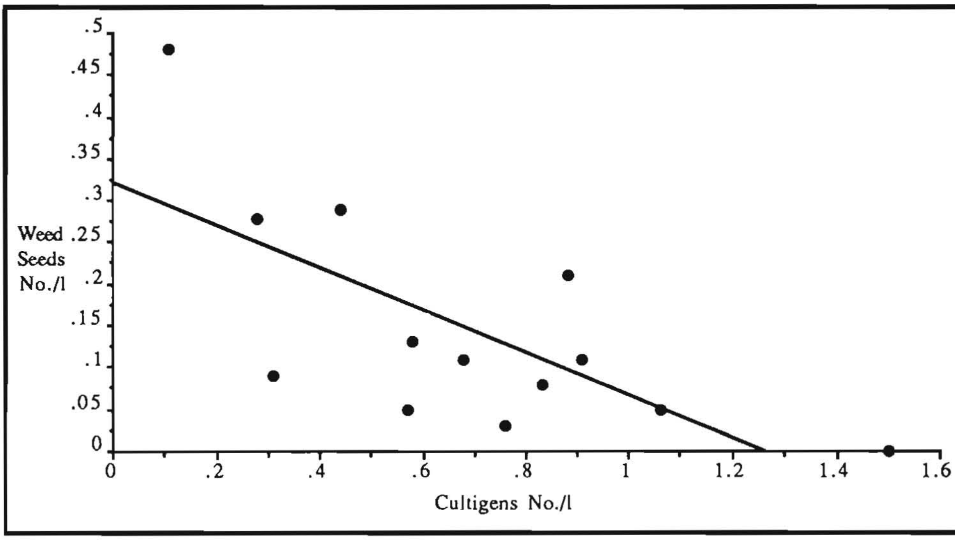

Fig. 15. Cultigen and weed-seed density correlation in Kazahari Pithouse 37 floor edges, Aomori.

ing are seen to be the only causes of high seed densities in floor edges, then one would expect all seeds to be similarly affected. However, because cultigens appear to be more prevalent in floor edges of the western quadrant, whereas weed seeds dominate in floor edges of the eastern quadrant, the depositional factors may have acted on cultigens and weed seeds that were originally concentrated in different areas of the pithouse. These accumulations may relate to ancient plant-processing activities or disposal areas.

Tokoshinai IV and Fukurashima Subsistence

A hallmark of the Late Jomon is thought to be the elaboration of maritime cultures throughout Japan, particularly on the Pacific coast of northeastern Honshu (Akazawa 1982; Chard 1974). Akazawa (1982: 196, 1986*b*) suggests that in this region, oceanic and littoral fishing dominated in coastal areas, while groups focusing on lake and riverine fishing were found inland. The remains of fish and shellfish on Tohoku shell mound sites are associated with a variety of fishing implements, such as toggle harpoon heads (closed socket) and fishhooks. Inland populations depended primarily on salmon fishing and land mammal procurement (bear and deer). These subsistence practices continued well into the Final Jomon period (Akazawa 1982; Chard 1974).

Although several researchers have suggested the presence of Late Jomon agriculture (e.g., Kagawa 1974), there is little in the way of archaeobotanical data to support these early claims. The Tohoku region, in particular, suffers from a lack of palaeoethnobotanical studies for this and most other periods. Recently, however, there has been a growing body of data that indicates the presence of Late Jomon domesticates, several instances of which are found in the northeast (see Crawford 1992*a* for a review). It seems that some kind of plant cultivation was in existence at least during the later Jomon (Anderson 1987; Crawford 1983, 1992*b*;

Tsukada et al. 1986), although the nature of these husbandry practices remains unclear. Although the Kazahari Tokoshinai IV data indicate the presence of domesticates in the region, at this time the evidence is insufficient to indicate the nature of cultivation and the palaeoeconomic role of crops.

Major cultural developments are evident during the following Final Jomon in northern Tohoku, with the appearance of the Obora ceramic phases (Kamegaoka) (Fig. 1). The Final Jomon is thought by some to represent the pinnacle of Jomon cultural elaboration (Aikens and Higuchi 1982; Ikawa-Smith 1988). Despite this apparent cultural complexity, Kamegaoka groups are usually assumed to have been supported by hunting, fishing, and the gathering of wild plants (Akazawa 1982; Ikawa-Smith 1988; Nagamine 1986; Rowley-Conwy 1984). This interpretation persists despite the fact that rice grains and paddy fields are known from Kamegaoka phase and other Final Jomon sites in Tohoku (Kuraku 1984; Murakoshi 1988; Sato 1984), indicating that during this time cultivation was a component of subsistence. In general, Final Jomon populations made use of a wide variety of faunal resources. Both coastal and inland sites are numerous during the Final Jomon, but Kamegaoka phase sites appear to be more numerous in inland areas. In coastal regions, sites have produced many types of harpoons and fishhooks, indicating that a variety of species was harvested, including sea mammals, anadromous fish, and marine species such as tuna and bonito (Aikens and Higuchi 1982; H. Watanabe 1986; M. Watanabe 1973). Inland sites show a focus on the procurement of deer, wild boar, and hare, and the presence of some marine resources indicates trade with coastal regions (Ikawa-Smith 1988).

The introduction of wet-rice agriculture dominates discussions in the literature dealing with Final Jomon subsistence, and the significance of other cultigens, such as millets and barley (*Hordeum vulgare*), is often ignored. Rice and other cultigens, including barley, buckwheat, *shiso* (*Perilla frutescens* var. *crispa*), mung bean (*Vigna radiatus* var. *radiatus*), and foxtail millet, are known from many Final Jomon sites in the southwest (e.g., Itoh 1984; Kasahara 1982, 1984; Kotani 1972; Mori and Okazaki 1962; Sato 1971; Yamazaki 1978). At the Kamegaoka as well as other sites in Aomori, rice grain and hulls are associated with Obora A ceramics, contemporary with Early Yayoi cultures in southwestern Japan (Sato 1984; Suto 1988). At the Sunazawa site, extensive rice-paddy fields dating to the later phases of the Final Jomon have been recovered. In addition, Ongagawa-type pottery and other Yayoi artifacts, such as glass beads, have been recovered from Sunazawa site deposits and from other Sunazawa phase sites in Aomori (Murakoshi 1988). Although in Tohoku rice remains dated to the Final Jomon were often interpreted as trade items obtained from southwestern Yayoi populations (Ikawa-Smith 1988), the discovery of the Sunazawa paddy fields (Murakoshi 1988) demonstrates that rice was being cultivated in Aomori during the Sunazawa phase, and perhaps as early as the Obora A phase at Kamegaoka (Crawford and Takamiya 1990). These finds suggest that once rice-paddy technology was introduced to the southwest it moved rapidly northeastward (Barnes 1993; Suto 1988). Evidence from Kazahari further suggests that the dispersal of rice and other crops may have preceded the movement of paddy technology (D'Andrea et al. 1995; D'Andrea in prep.).

Some archaeologists have suggested that rice agriculture may not have been equally successful over all of Tohoku. Where it was difficult to grow rice, millet may have been the preferred crop (Itoh 1984). In this regard, Suzuki (1986) notes that the cold Oyashio current, which affects the eastern coast of Tohoku, makes rice agriculture unreliable. Even today, cold-damaged rice crops are more common there compared to western Tohoku. The distribution of rice-producing sites in Aomori is thought to reflect this climatic difference. As of 1986, 10 out of 18 Final Jomon and Yayoi sites that yielded rice remains are located in the west, including the two that have produced rice-paddy fields (Sunazawa and Tareyanagi) (Suzuki 1986). Additional flotation sampling of Late and Final Jomon sites in Aomori is necessary to test this hypothesis.

Crawford and Takamiya (1990) have drawn attention to the lack of data available on the range of crops grown by later Tohoku Yayoi populations. Historical data from the region indicate that other crops, especially barnyard millet, were important economically in Tohoku until recent times. For example, Yabuno (1987) describes the tombs of three individuals, belonging to a powerful family in twelfth-century A.D. Iwate Prefecture, who were buried with barnyard millet. It has been reported that barnyard millet was a dominant crop until the Meiji period in many areas of northeastern Tohoku, including the Shimokita Peninsula, Sambongi, and the Kitakami Uplands, and it was frequently grown in paddy fields (Ichikawa 1985). Others have suggested that the farming of millets, beans, and barley was at least equal in importance to rice agriculture (Terasawa 1986). In view of the historical importance of barnyard millet in eastern Tohoku, Crawford and Takamiya (1990) suggest that non-rice-based agriculture, such as one involving millet husbandry, may have developed in Tohoku. Ultimately, Tohoku Yayoi populations were ancestral to the Ezo cultures of Hokkaido. These Ezo peoples were also involved in the intensive exploitation of millets (Crawford and Takamiya 1990; Crawford and Yoshizaki 1987). Additional archaeobotanical sampling in Aomori is required to elucidate the antiquity of millet husbandry in this region.

DISCUSSION

The presence at Kazahari of Tokoshinai IV phase rice, foxtail, and broomcorn millet requires some discussion of how these cultigens arrived at this northern area at such an early date, how they came to be charred in the site deposits, and the possible role they played in the Tokoshinai IV palaeoeconomy. Unfortunately, there is no comparative archaeobotanical material available in Aomori. As a result, an attempt at later Jomon subsistence reconstruction will be made by examining the context of the Kazahari plant remains, in addition to making reference to historical and ethnographic literature on rice and millet husbandry.

From the study of archaeobotanical remains from Kazahari Pithouses 32 and 37 it was concluded that the distributions may reflect something of the depositional history of the pithouse floor. These distributions suggest that recovered plant materials represent a homogenized mixture of what was used in everyday subsistence activities, and in this way the pithouse floor is somewhat analogous to a midden deposit. The large number of unidentifiable seed fragments in both pithouses suggests that seed destruction took place due to sweeping, trampling, and exposure to other erosional forces.

It is difficult to estimate the economic importance of these cultigens based on the small samples recovered from Kazahari. If, however, one assumes that the pithouse floors represent a homogeneous mixture of plant remains deposited over a period of time, the presence of these cultigens at all suggests that their palaeoeconomic role may not have been minor or incidental. This view is certainly applicable to Fukurashima phase Pithouse 37, where there is a more obvious presence of cultigens. The Pithouse 37 remains are consistent with other evidence of domesticated plants known to have been present at the end of the Jomon period in Tohoku.

Ethnographic literature on rice and millet cultivation can provide information that is relevant to the interpretation of the Kazahari samples. As stated earlier, millet husbandry is successful in northeastern Tohoku today, where rice-crop failures are common (Yabuno 1987). In general, millets mature in a short period of time, some in as little as six weeks, and they require less tending than many cereals (Chang 1983). The three Far Eastern millets—foxtail, broomcorn, and Japanese barnyard millet—can tolerate extreme ranges in environmental conditions. Broomcorn and Japanese barnyard millets have extremely low water requirements and are well adapted to both semiarid and high-altitude conditions. Although foxtail millet is not as drought-tolerant, it can survive a wide range of soil conditions (Chang 1983; Purseglove 1972). Similarly, rice is able to tolerate various substrates, but requires abundant water and summer monthly mean temperatures of 20°C. Today, rice is grown throughout Japan, but cultivation in northern Hokkaido is limited by minimum diurnal temperatures in mid-May and the number of frost-free days (Bray 1984; Grigg 1974; Trewartha 1965).

The hardiness of millets and rice is documented in historical records of dryland farming in northern China, where there is a 2000-year tradition of recording agricultural practices (see Bray 1984 : 47–85, for a review). One of the earliest known texts on Chinese agriculture dates to the early Han Dynasty (latter half of the first century B.C.) and was written by the prominent agronomist Fan Sheng-Chih. As is the case with many early agricultural treatises, the original volume is lost and the work exists only as fragmentary quotations in later publications. These fragments have been compiled into a book by Shih (1982), who provides discussions on the techniques described by Fan. The text focuses on farming practices prevailing in the arid districts of the middle Huang Ho River (the "Loop") in northern China. Shih (1982) suggests that the techniques discussed in the work were not invented by Fan, but reflect widely used and well-established practices that he observed and recorded. Many of the methods discussed were geared to loess soils that were deficient in humus, phosphorus, and nitrogen. When this text was written, erosion due to agricultural activities in northern China was rampant and forests were on the decline. Both drought and floods were commonly recurring problems. Although the climate of northern China is continental, the summer mean temperature is 24-26°C, well above that required for rice farming (20°C). The crops making up this dryland system included foxtail and broomcorn millets, winter and spring barley and wheat, beans (including soybeans), melon, gourd, taro, hemp, *shiso*, and water darnel (*Panicum* sp.). Paddy rice was also grown in small plots in wetland areas. It is noteworthy that the remains of all these crops, except for taro, soybean, and wheat, have been recovered from Jomon archaeological sites. Fan (in Shih 1982) discusses the character of rice growing in the primarily millet-based agricultural system prevailing in northern

China at the time. Prior to the Zhou Dynasty, rice was of marginal importance in the area (Chang 1983). Fan suggests that wet-rice agriculture was practiced successfully in this relatively inhospitable environment, and he describes several techniques used to protect crops from frost and cold spring temperatures (Shih 1982).

The nature of modern farming practices may give the impression that rice can be grown only in a context of labor-intensive and highly specialized paddy fields. However, ethnography has demonstrated the existence of many rice cultivation techniques, some of which do not require irrigation. Lambert (1985 : 73–75) describes some of these methods, and it is clear that they are not easily categorized into traditional "wet" and "dry" systems. For example, swamp rice is grown in low-altitude marshlands fed by rainfall. Several techniques of swidden rice cultivation also are known, with fields located in marshes or on hillsides. Unirrigated rice grown in swidden fields is sometimes referred to as dryland paddy cultivation (Grist 1975 : 180–182). Traditional methods such as these are relatively widespread in Southeast and South Asia (Lambert 1985).

Ancient Chinese texts document the practice of seeding rice by broadcast into low-lying natural ponds and swamps, and this technique may have its origins in prehistoric times (Ho 1977). In terms of Far Eastern agricultural history, paddy technology is a relatively recent innovation that appeared sometime after 700 B.C. (Chang 1983; Ho 1977). Recent archaeological evidence indicates that domesticated rice was present in southern China by at least 7000 B.P. (Chang 1989). Consequently, rice was cultivated for many centuries without paddy irrigation, indicating that, in China, the origins of wet-rice paddy agriculture should be considered a separate issue from the origins of rice husbandry. The Kazahari data suggest that a similar pattern should be considered for Japan (D'Andrea et al. 1995).

The document produced by Fan Sheng-Chih was written at a time not far removed from the Fukurashima groups that occupied Pithouse 37. At that time, populations in northern China were involved in intensive agriculture that included techniques for dealing with cold and relatively inhospitable conditions. When considered in this light, the presence of rice cultivation in the Tokoshinai IV phase at Kazahari is not improbable. Although eastern coastal Tohoku may have been as inhospitable to rice growing as it is today, methods in the past were available to ameliorate the effects of cold. Still, millet harvests may have been more reliable.

The archaeobotanical data from Kazahari would also be less anomalous given the existence of horticulture as a component of Jomon subsistence. Recent research suggests the presence of swidden, and there does seem to be some indication that several dispersals of cultigens from the continent took place early in the Jomon period (Crawford 1992*b*; Tsukada et al. 1986). Evidence from Torihama, Hamanasuno, Usujiri B, and other sites demonstrates that the cultivation of buckwheat, foxtail millet, barnyard millet, hemp, great burdock (*Arctium lappa*), peach (*Prunus persica*), *shiso*, bottle gourd (*Lagenaria siceraria*), and paper mulberry (*Broussonetia papyrifera*), and the possible husbandry of wild species such as barnyard grass, had begun by the Early Jomon period. In addition, there are indications that anthropogenic impacts are more pronounced beginning by the Early Jomon. Through the examination of charred weed seed assemblages preserved at several

Jomon sites, Crawford (in prep.) concludes that land clearance for the purpose of gardening was responsible for the greater degree of anthropogenesis visible in the archaeobotanical record from Early to Late Jomon times. Unfortunately, these data are not sufficiently detailed to indicate the economic significance of various crops or the nature of their cultivation. Rice appeared in southwestern Japan by the Late Jomon period, and, based on evidence from Kazahari, it may have been present in northern Tohoku as early as the Late Jomon Tokoshinai IV phase. Its early presence in the northeast could have been the result of trade or diffusion. Alternatively, rice, taken out of an irrigation context, could have been incorporated into a dryland horticultural system that was a component of Jomon subsistence. Such a system has been documented in China during the first century B.C. and may have existed during prehistoric times (Ho 1977 : 447).

Unfortunately, in dealing with the Kazahari Tokoshinai IV remains there is still no way of determining whether rice was grown locally or traded from southwestern Japan. Perhaps the presence of a range of crops such as millets and barley can provide further support, but this may not be reliable. Nevertheless, the attempt to demonstrate the presence of prehistoric rice farming should not rely so heavily on the existence of paddy fields. The areas surrounding the Kazahari site, in the Niida River floodplain with abundant low-lying alluvial soils, could have provided appropriate habitats for rice farming in shallow pools of water.

Although the above discussion on northeastern Tohoku later Jomon plant husbandry is based on a relatively small data set, it may encourage archaeologists to look beyond hunting-gathering-fishing as the only form of subsistence activities practiced by Late Jomon populations in the northeast. This area encompasses a number of microenvironments where plant cultivation could have flourished along with marine-focused subsistence. Although the plant remains from Kazahari do not indicate that rice and millets were grown on site during the Tokoshinai IV phase, ecological and ethnohistorical evidence suggests that farming was possible in Tohoku during this time. Data from Kazahari and other sites in the Tohoku area show that, certainly by the Final Jomon–Tohoku Yayoi periods, wet-rice and millet farming were established in the region. Although southwestern influences are apparent in the development of the Tohoku Yayoi, some domesticates (rice and broomcorn and foxtail millets) are present as early as the Late Jomon, prior to the introduction of paddy fields and other Yayoi technology.

CONCLUSION

The data produced in this study provide a first glimpse of plant resource use during the later Jomon of eastern Aomori. The distribution of plant remains in pithouse floors provides some provisional support for Kobayashi's (1974) model of pithouse deposition based on ceramic data, although results are not conclusive in every case. Some patterns were observed in the pithouse floors that could be explained as the result of depositional factors, but additional examples are needed. Crawford (1993) is achieving some success in this regard.

The late Middle Jomon site of Tominosawa produced a spectrum of archaeobotanical remains similar to that uncovered at contemporaneous sites in southwestern Hokkaido (Crawford 1983). At the Kazahari site, rice, foxtail millet, and broomcorn millet were recovered from Late Jomon Tokoshinai IV contexts.

Radiocarbon dates for the rice support the hypothesis that the northward dispersal of rice in Japan was more rapid than previously thought (D'Andrea et al. 1995). Approximately 1000 years later, and contemporary with Middle Yayoi cultures of southwestern Japan, Fukurashima phase people at Kazahari were growing rice, foxtail and broomcorn millet, Japanese barnyard millet, and hemp. The wide range of wet and dryland crops under cultivation during this time suggests the presence of well-developed horticultural activities. Historically, Japanese barnyard millet was economically important in northeastern Tohoku, but exactly when this pattern developed is still unknown.

Although farming was clearly a subsistence activity by the Final Jomon Fukurashima phase and among later populations in northern Tohoku, a similar observation cannot be made for the Late Jomon period. Although the remains of three domesticated species have been recovered from Kazahari Tokoshinai IV contexts, there is no unequivocal evidence that horticultural activities occurred in the region. However, data on the ecological requirements of rice and millets, in addition to historical accounts of farming in northern China, suggest that the small-scale cultivation of these crops in southeastern Aomori during the Tokoshinai IV phase remains a distinct possibility. And though the question of Jomon agriculture has been a source of debate in Japanese archaeology for many years, recent evidence supports its existence, at least as a minor component of Jomon subsistence, in both southwestern and northeastern Japan (Crawford 1983, 1992*b*; Tsukada et al. 1986). During the Late Jomon of Kazahari, rice cultivation, not involving complex wet-paddy techniques, may have been added to an existing swidden system that had as its components millets, buckwheat, and other crops. The archaeological evidence suggests that a frontier of wet-rice paddy technology swept across Japan during the Yayoi period, but that, prior to this time, the small-scale cultivation of rice and millets was practiced. This indicates that, in northeastern as well as southwestern Japan, the establishment of plant husbandry practices, including rice cultivation, preceded the influx of Yayoi cultural influence.

ACKNOWLEDGMENTS

This research was funded through a Natural Sciences and Engineering Research Council of Canada Doctoral Fellowship (1985–1987) and a Japan Foundation Dissertation Fellowship (1989). I am grateful to the Hachinohe City Board of Education, and to T. Kudo, for the opportunity to conduct archaeobotanical sampling at the Kazahari site. I would like to thank the Aomori Salvage Archaeology Centre, and in particular M. Miyake, for permission to work at the Tominosawa site. M. Yoshizaki (Hokkaido University) was instrumental in organizing and supporting the research, and Y. Tsubakisaka (Hokkaido University) provided essential technical advice. Many thanks go to G. W. Crawford (University of Toronto), who supported all phases of the work and provided funding for radiocarbon dating. I am grateful to L. A. Pavlish, G. W. Crawford, M. Graves, and an anonymous reviewer for their critical comments on various drafts of this manuscript.

NOTES

1. In both Kazahari pithouses, "Total Walnut Shell" includes the heavy-fraction in addition to the light-fraction weights, giving a total estimated value of walnut shell for the context. As a result,

the only contexts included in figures are those where heavy fractions were analyzed. The addition of the heavy-fraction walnut shell results in its overrepresentation in absolute values compared to wood charcoal, because charcoal was not sorted in the heavy-fraction samples.
2. The data from three floor subunits were not included in this correlation.
3. The data from four floor subunits were not included in this correlation.

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ABSTRACT

This paper discusses prehistoric subsistence and the development of plant husbandry in northeastern Tohoku (northern Honshu). Archaeobotanical sampling was carried out at two sites in eastern Aomori Prefecture. Tominosawa is a Middle Jomon village site which produced a spectrum of nut and weedy plant species similar to that recovered from contemporary sites in southwestern Hokkaido. At the Kazahari site, pithouses from two phases of occupation were sampled for archaeobotanical remains: Tokoshinai IV (c. 1000 B.C.) and Fukurashima (c. 150 B.C.). The pithouse deposits produced evidence for Late Jomon rice, foxtail millet, and broomcorn millet dating to the first millennium B.C. Sampling of later Fukurashima contexts produced evidence of rice, foxtail and broomcorn millet, Japanese barnyard millet, and hemp. These data demonstrate that rice and millets have been present in northeastern Tohoku since c. 1000 B.C., and that farming systems were in place during later Fukurashima occupations. Ecological and ethnographic evidence is used to postulate that plant husbandry was possible in the area during Tokoshinai IV. It is concluded that the northward dispersal of rice was more rapid than was previously thought, and consequently that this movement may not have been greatly affected by cultural and ecological constraints. In addition, rice cultivation dispersed into northeastern Japan independently of wet-paddy technology. KEYWORDS: Japan, Tohoku, Jomon, subsistence, cultivation.